DOCUMENT RESUME

ED 195 419 SE 033 414

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TITLE Final Report of the Improvement of School Programs in Mathematics Through a Comprehensive Foundation Program Assessment and Improvement System (FPAIS) Approach Project (1977-80).
INSTITUTION Hawaii Univ., Honolulu. Coll. of Education.
SPONS AGENCY Hawaii State Dept. of Education, Honolulu. Office of Instructional Services.
PUB DATE 80
NOTE 63p.

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS *Curriculum Development: *Educational Assessment: Elementary Secondary Education: *Evaluation: *Mathematics Curriculum: *Mathematics Education: *Mathematics Instruction: Pilot Projects: Program Descriptions: Research Reports: State Curriculum Guides
IDENTIFIERS *Mathematics Education Research

ABSTRACT

The Improvement of School Programs in Mathematics through a Comprehensive Foundation Program Assessment and Improvement System (FPAIS) Approach Project is described. This project used a multi-pronged approach to reach the objective of reducing mathematics program deficiencies as identified through state-level assessments. The two major ways to bring about needed change were: (1) the development and implementation of curriculum modules into the classroom that would use a newly-structured mathematics program, and (2) the development of a school-level leadership team competent in FPAIS methodologies. The changes in the mathematics program included a variety of assessment and improvement efforts designed to have a lasting impact on learners. A statewide Mathematics Program Guide, a curriculum management system, and a model for a coordinated mathematics program were all developed by the project. Among the report's recommendations, the school-level assessment and improvement model, the curriculum guides, and the new materials are all promoted for immediate coordinated statewide use. (MP)

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FINAL REPORT

OF

THE IMPROVEMENT OF SCHOOL PROGRAMS IN MATHEMATICS THROUGH A COMPREHENSIVE FOUNDATION PROGRAM ASSESSMENT AND IMPROVEMENT SYSTEM (FPAIS) APPROACH PROJECT

(1977-80)

by

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SE 033 414

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THE MEMORY OF

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Prepared for the Department of Education, State of Hawaii,
Office of Instructional Services
in pursuance of
Memorandum of Agreements 1977-78, 1978-79, 1979-80
between the University of Hawaii and Department of Education

1980

ACKNOWLEDGMENTS

I wish to acknowledge the help provided by students, teachers, principals, district and state educational specialists, district resource teachers, project staff and assistants, and consultants.

Thanks to the leadership teams: Aina Haina Elementary, Baldwin High, Castle High, Hahaione Elementary, Heeia Elementary, Hilo Intermediate, Hilo High, Iao, Kailua Intermediate, Kainalu Elementary, Kalaheo (Kauai), Kaneohe Elementary, Kapaa High, Kapiolani, Kaunakakai Elementary, Kekaha Elementary, Kihei, Koko Head Elementary, Likelike Elementary, Paia, Wahiawa Intermediate, Waiahole Elementary, Waiakea Elementary, Waiakea Intermediate, Waiakea High, Waiakeawaena Elementary, Wailuku Elementary, Waimea High, Wheeler Intermediate, and Wilson Elementary Schools.

Thanks to the teachers for trying out the modules: Castle High--Henrietta Muramoto; Hilo High--Gladys Miura and Edna Shigeoka; Honowai Elementary--Irene Asakura, Ritsuko Fukuda, Margy Kodama, Evelyn Shiroma, and Jo-Anne Yamada; Jefferson Elementary--Mona Smoot; Kaelepulu Elementary--Shirley Yamashiro (principal) and staff; Kailua High--George Arakaki and Harry Murai; Kalihi-kai Elementary--Elaine Chung, Nancy Miyoi, Betsy Tonda, Margaret Toyoda, and Mitsuko Yamaguchi; Kapaa Elementary--Robert La Madrid (principal) and staff; Kaunakakai Elementary--Edward Kashiwamura (principal) and staff; Kualapuu Elementary--Randy Kobayashi (principal), Allen Ashitomi, Amy Fujimoto, Earline Iaea, Carmen Ikehara, Grace Kashiwamura, Lorraine Kent, Emily Mondoy, Theone Puhi, Lorraine Rhyne, Leslie Tamura, Joyce Waipa, and Gladys Watanabe; Lahainaluna High--Stanley Nagamatsu; Leilehua High--Colleen Umetsu; Maunawili Elementary--Robert Ogata (principal) and staff; Moanalua High--Linda Ito and Juliette Tom; Wahiawa Intermediate--Myron Brumaghim and Lucy Yokoo; Waiau Elementary--Sharon Asato and Connie Mark; Waipahu High--Merle Miyashira; Washington Intermediate--Chuck Adams and Larry Miyasato; Wheeler Intermediate--Richard Okuma, Arlene Oyabu, and Sharlyn Tomimoto; and Wilcox Elementary--Setsuo Ushio (principal), Takao Muramaru (vice-principal), Beverly Brun, Thelma Chun, Gladys Fujiuchi, Daniel Hamada, Beatrice Hashimoto, Machie Kubota, Clare Morishige, Flora Oda, Arleen Waiamau, and Donna Yano.

Thanks to the district and state educational specialists: Richard Akiyama, Sylvia Koo, Nellie Matsunami, Albert Nagata, Toshio Seki, Shuichi Tanaka, Violet Todoki, and Ronald Toma.

Thanks to the district resource teachers: Arnold Fujii, Geraldine Ichimura, Lois Lum, Carmielita Minami, and Warren Takushi.

Thanks to the project staff and assistants: Carole Sue Atkins, Celita Chanh, Gloria Chun, Gertrude Ebesu, Charles A. Giuli, Lorraine Haraga, Li Ann Hirata, Evelyn Horiuchi, Arleen Kawabata, Kimberly Kihara, Irv King, Paul Kwan, Morris Lai, Jane Macari, Elizabeth Jane Manuel, John Marks, Helen Masui, Kathleen Nishimura, Linda Saito, Harriet Scheuermann, Arleen Singer, Cynthia Suehiro, Sue Tanabe, Carol Tanimoto, and David Tanner.

Thanks to the consultants: Edward Bertram, Frederick G. Braun, Gertrude Ebesu, Jane Fultz, Violet Hara, Robert Heath, Ralph Heimer, Mildred Hora, Geraldine Ichimura, George Immerzeel, Geraldine Kajitani, Sarah Kauka, Arthur R. King, Jr., David Lani, John LeBlanc, Frances Link, Amy Maeda, Carmielita Minami, Annette Nishimura, Anthony J. Picard, Alex Pickens, Thomas Romberg, Ross Taylor, Paul Trafton, Ruth Wong, and Fay Zenigami.

In particular, I wish to thank Mildred Higashi of the Office of Instructional Services who helped me learn about the Department of Education and to James W. Wilson of the University of Georgia whose comments, suggestions, and questions crystalized my thinking about the overall framework and philosophy of the project.

I am very grateful to all persons who have contributed to the project and apologize if I should have unwittingly forgotten to recognize them.

Nancy C. Whitman

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I. Introduction

The Improvement of School Programs in Mathematics through a Comprehensive Foundation Program Assessment and Improvement System (FPAIS) Approach Project, hereinafter referred to as the "Comprehensive Mathematics Project," is a Title IV-C project and originated in response to numerous concerns and circumstances in mathematics education in the State of Hawaii. Some of these mirrored the concerns and circumstances that are being expressed nationwide and reflect the statewide test results that have steadily declined in the years preceding the project. Coupled with this decline had been a vocal lay concern regarding the graduates' lack of achievement in areas considered very basic, such as reading, writing, and arithmetic.

At the state level in the Department of Education, hereinafter referred to as the "Department," there were inadequate curriculum documents--the latest mathematics continua having been published in 1972 for grades K-3 and 4-8. As a consequence of this inadequacy, several abortive attempts had been made toward developing a curriculum framework for the mathematics programs. A set of objectives was needed that would relate the mathematics curriculum area to other curriculum areas and to the Department's Foundation Program Objectives. In addition to these objectives, improved inservice was needed to facilitate the state's move toward competency-based instruction.

The Comprehensive Mathematics Project was proposed to bring about changes in the state's mathematics program by utilizing a comprehensive approach through a variety of assessment and improvement efforts that would have a lasting impact on learners. These efforts were to include: (1) restructuring the statewide mathematics curriculum to conform to the Foundation Program Objectives, (2) modifying mathematics instruction to better provide

for individual differences for the full range of learners in the public schools, (3) providing staff inservice education and support to enable schools and teachers of mathematics to conduct effective school-level assessment and improvement activities, and (4) coordinating the range of provisions in mathematics education at the school, district, university and state levels.

Objectives of the Project

The major objective of the project was to reduce mathematics program deficiencies as identified through state-level assessments. To this end a restructuring of the state's mathematics curriculum was needed to guide classroom instruction toward the development of each student's fullest potential. In addition, a comprehensive objectives-referenced system for school-level assessment of student achievement in mathematics was needed. Hence, the improvement of instruction both in the context of implementation of the new state framework and continuum in mathematics and in the context of school-level assessment and improvement activities resulting in the learners' fullest development in mathematics served as the major objective. A subobjective was to determine the effectiveness of various vehicles in bringing about change and improvement in school mathematics programs. In particular, these possible change agents include: (1) the use of modules for curriculum development, (2) the use of FPAIS methodologies at the school level, and (3) leadership training. The first includes classroom instructional units, course guides and samples, complete K-6 and 7-8 instructional programs; the second includes assessment and improvement activities at the school level; and the third includes a training package for school-level leaders in the restructured mathematics curriculum and FPAIS methodologies.

Relationship Between the Project and the State Mathematics Program

This project was begun on July 1, 1977, at which time the state mathema-

tics program was without an official manager. (The manager had just resigned.) In lieu of a manager, the Director of the Division of Sciences and Humanities, wherein the area of mathematics is housed, assumed many of the responsibilities of the mathematics program manager. In addition to lacking a mathematics program manager, the state also needed a comprehensive K-12 mathematics framework. A team of nine classroom teachers were contracted by the Department to develop such a framework along with a K-12 continuum. The project was to provide guidance and technical assistance to this effort and to assemble a first draft from the many elements discussed by the nine-member committee. Work by this committee commenced on June 30, 1977. By the end of the summer, various parts, some being more complete than others, of the mathematics framework and continuum were drafted. These writings were integrated into a first draft of the current Mathematics Program Guide. Concurrent with the Mathematics Program Guide's development was the Department's development of performance expectations for various program areas including that of mathematics for grades four, six, eight, and ten. By August 1977, the Department decided that the mathematics performance expectations needed to be revised completely. The project drafted the first revised version of the mathematics performance expectations and assisted in its subsequent redrafts (Department of Education, August 1978).

To proceed with its work, the project needed data on the mathematics achievement of students in the public schools. These, in conjunction with the newly formulated Mathematics Program Guide and its corollary performance expectations, were to serve as the basis on which statewide deficiencies in mathematics were to be identified and ranked for possible program development. Unfortunately, as with the mathematics framework and continuum, the data were not ready for project utilization. As a consequence, the project assisted with the analytic report of statewide test data on mathematics

achievement (Lai, 1977). Not only was the needed data on student achievement not available, but the state testing system was in a period of transition--the Department being in the process of developing a mathematics program correlated Stanford Achievement Test computer printout. Again the project assisted in this effort (Lai and Scheuermann).

In addition to aiding in the restructuring of the state's mathematics program by providing guidance and technical assistance in the drafting of its program guide and performance expectations, the project assisted in the collection, evaluation and annotation of existing instructional materials to identify areas with limited commercially-produced and available materials, and production of a comprehensive instructional materials resource list for use by classroom teachers. The Authorized Course and Code Numbers (ACCN) of the Department was also reformulated with project assistance to reflect the restructuring occurring in the state's mathematics program (Department of Education, August 1979).

An unusual situation existed in the relationship of the project and the state mathematics program. In the years of the project, its administrator was also functioning as a mathematics consultant to the Department. As a consequence, the amount and kind of communication was greater than would be expected between two contracting agencies.

II. Methodology

A Multi-Pronged Approach

To attain the major objective of reducing mathematics program deficiencies as identified through state-level assessments, a multi-pronged approach to change and improvement was decided upon. This included an assessment of test and non-test data, the development and incorporation of curriculum modules into classrooms, and the initiation of school-level leadership training. The assessment of test data consisted of a statewide analysis of the 1976-77 Stanford Achievement Test results and the 1975 Needs Assessment data. The assessment of non-test data consisted of a study of Department curriculum documents, including a draft of the performance expectations, of its Foundation Program Objectives and the Mathematics Program Guide. In addition, substantial reports and recommendations of such committees as the National Advisory Committee on Mathematics Education and the National Council of Supervisors of Mathematics were studied (NACOME, NCSM).

The study of both test and non-test data resulted in the identification of areas in mathematics education in which the state mathematics program was deficient. Since it was impossible to attend to all of the areas identified as deficient, a set of criteria for prioritizing deficiency areas was developed and utilized. A report summarizing the results of the study of test and non-test data and the subsequent prioritized list of statewide areas of deficiency in mathematics education was made available to the Department which in turn communicated the results to the school districts in the state (Whitman, 1978).

The use of the assessment results to serve as an initiator of change was envisioned. Deficiencies in mathematics education had been identified and leaders in the Department were made aware of them. Now a means to remove

or reduce them was needed. What possible changes could be made in the mathematics program and how? Two ways to bring about needed change were anticipated. These were: (1) the development and implementation of curriculum modules into the classroom using the newly-restructured mathematics program and (2) the development of a school-level leadership team competent in FPAIS methodologies. What follows is a discussion of the use of curriculum modules in bringing about change and improvements.

Curriculum Modules

A curriculum module as used in this report may be a classroom instructional unit of only three weeks duration or it may consist of a complete mathematics program in a given school. In particular, a module includes the following components: (1) specific related mathematics instruction principles identified as learning prescriptions for students, (2) teacher guidelines for implementing learning strategies and components, (3) alternative learning materials for students which provide for diverse learning modes, (4) comparative listing of references to suitable existing instructional materials, and (5) strategies for broad application of identified principles from mathematics teaching and learning areas where suitable materials are non-existent (Department of Education, July 1977).

The use of new instructional materials to bring about change is a known strategy in mathematics education. It was widely used during the 1960's when "new math" programs were introduced. It was demonstrated, then, that linked with a strong inservice support system the strategy could bring about desired changes. An example may be seen in the secondary school mathematics program where, with the availability of new instructional materials and its correlated inservice support supplied by the National Science Foundation, desired changes in the mathematics curriculum were noted.

In studying the impact of the implementation of new instructional modules there is a need to view not only the results of students' achievement but also their perceptions of mathematics. In addition, there is need to study changes occurring in the teachers and administration. Have such changes in either one of them resulted in changes in other classrooms, in the school's program, and so on? Were they changes of a temporary nature--perhaps lasting only the life of the project? Were they restrictive, that is, appearing only in an isolated part of the staff and curriculum?

The implementation of the modules into a school's curriculum has to be nurtured by the school's leadership. Hence, the development of school-level leadership teams was considered as another means by which changes might occur. What follows is a discussion of the use of school-level leadership teams to bring about changes and improvements.

School-Level Leadership Teams

The Department has a system (FPAIS) for monitoring curriculum at the state, district, and school levels (Department of Education, December 1977). The system is currently in operation at both the state and district levels; however, its usage at the school level has been nonexistent. It was decided that the project's school-level leadership teams would be trained in the methodologies of this system. Essentially, it maintains that the principal must be a member of the team and that the school, under the team's leadership, would engage in various assessment and improvement activities on a continuing basis.

Before the teams could be trained in the methodologies of this system, however, it had to be interpreted in the context of mathematics education. This was done by the project and has resulted in the development of various assessment and improvement instruments referred to as "schedules." These

schedules incorporate the guidelines of the newly-restructured mathematics program. Hence, the training of school-level teams in FPAIS methodologies consisted of instruction in the use of various assessment and improvement schedules for school mathematics, in addition to the state's restructured mathematics program and performance expectations. They were also made aware of the trends and issues in mathematics education nationwide and how Hawaii reflects these trends and issues.

In studying the impact of leadership training there is a need to look beyond the team itself. Not only must we ask whether changes occurred between team members, but also whether they resulted in changes in the school's program in the most general sense. For example, do we see changes in teacher inservice requests, in the curriculum, in instructional techniques, in the evaluation of curriculum changes? It was anticipated that the training of school teams in FPAIS methodologies and, in turn, their application of these methodologies at their schools would result in the desired changes in mathematics education.

Changes and improvements at the schools that have incorporated modules and/or have participated in the training and application of FPAIS methodologies cannot be attributed totally to these possible change agents. Other change agents concurrently in operation must be considered. Following is a discussion of other activities of the Department affecting changes and improvements and the interaction of these acitivities with those of the project.

Other Activities of the Department of Education Affecting Changes and Improvements

At the start of the project and throughout its duration the Department engaged in numerous activities that encouraged and facilitated the changes needed in mathematics education. These are:

1. The implementation of the Mathematics Program Guide. The mathematics framework and continuum for the State of Hawaii was officially made available to the schools during the second year of the project. The final draft of the guide was made available to participating schools in the project during the first year of the project. The impetus for change that the guide provided cannot be overstated. Numerous orientation sessions for teachers and administrators regarding the guide took place independent of the project. However, the project administrator serving in another capacity, was centrally involved in these activities. In this other capacity, the project administrator had helped analyze the feedback regarding the draft of the guide and helped to finalize the guide. These activities influenced the activities of the project. The project was able to provide participating schools the needed inservice on the newly-restructured mathematics framework and continuum.

   The Mathematics Program Guide was used as the basis for numerous project activities. It served in the development of the assessment and planning for improvement schedules. It was a major document and a non-test datum studied to determine the areas of deficiency in the state's school mathematics program. It was used as a means of organizing and categorizing standardized test data. In the Department, it was the basis on which the authorized courses and code numbers (ACCN) were organized and developed for students in grades nine to twelve. Since schools must register students for credit using these course code numbers, changes in them precipitated changes at the school level. All this facilitated the activities of the project in bringing about changes at the school level.

2. The development of competency-based education. This development helped schools focus attention on the most basic areas of mathematics. In the past, schools tended to focus attention on computation skills alone; now, the nature of basic mathematics was enlarged to encompass process behavior, including problem solving, and the content areas of measurement and geometry. In effect, competency-based education necessitated the clarification of program goals. By providing general goals for mathematics education, the state provided a needed set of parameters in which the district and schools could operate. Without these parameters, it would have been impossible for the project to develop a set of instruments for assessing and planning improvement which would have applicability to the mathematics programs of different schools.

Competency-based education has also helped schools focus attention on all students. This is especially true at the high school level where, in the past, attention was focused on the mathematics education of those preparing for college. The development and piloting of the Hawaii State Test of Essential Competencies (HSTEC) by the Department brought the need of schools to develop programs for the less successful in mathematics into sharp focus. Plans by the Department to develop and to pilot tests that measure the recently-developed performance expectations at grades four, six, eight, and ten emphasized the need for school programs to attend to and show the achievement of all students in the areas of geometry, numbers and operations, and measurement. All activities related to the Department's competency-based education policy affected change and improvement in the school's programs. Much discussion and communication regarding these

activities were carried out in the project's efforts with the schools.

3. The increasing of the mathematics requirement for high school graduation. By the end of the second year of the project, the Department had raised the high school mathematics requirement from one unit of study to two. This increase demanded more planning of the school's mathematics program. To this end, both the Department and the project served as change agents. The increase in mathematics requirement for high school graduation provided the needed time for instructing students in the basic skills of mathematics; in particular, those that were identified by the Department as being essential (Department of Education, August 1977).
4. The development of curriculum guides. The focus on the less-successful in mathematics prompted the need for appropriate programs for these students. For the past two decades, the emphasis had been on college preparatory students; now, there existed a need to shift that focus. The Department had already restructured its mathematics program so that greater flexibility in courses to teach the less-successful mathematics students was possible. Specific course guidelines and sample courses of study, however, were lacking. To remedy this situation, the Department had curriculum guidelines developed through a variety of means. One of these involved having the project develop course guides and possible courses of study.

By the end of the second year of the project, the Department had developed and made available to the participating pilot schools a total of seven curriculum guides. The communication of materials developed by the Department and the project to participating schools in assisting them in their program planning was included among the efforts of the

project. On the other hand, the Department communicated the materials developed by the project to the field. Again, we see the interaction of Department and project activities in bringing about changes in the schools.

5. The identification of reading as priority #1. During the initial year of the project the Superintendent of Education publicly announced that reading was the top priority area for the Department. By the end of the second year of the project, the statewide framework for reading was adopted (Department of Education, June 1979). It states that subject-area teachers are responsible for teaching the specialized reading expected in their content areas. This identification, along with the mathematics guide's emphasis on communication and problem solving, encouraged change at the school level. Modular materials and assessment and improvement planning activities by the project also emphasized communication, reading, and problem solving. Again, change encouraged by both state and project activities may be seen.
6. The inservice training of teachers for problem solving. In response to teachers' expressed need for assistance in teaching problem solving, the Department sponsored workshops providing them with the necessary knowledge and skills to make changes in their instructional techniques. Participation was due to project activities or Department emphasis on reading and problem solving.

III. Products of the Project

The products of the project may be grouped into four major categories. These are: (1) products that have helped to define the parameters of the project, (2) products that are curriculum modules or other materials directly affecting classroom instruction, (3) products that are components of a model for the assessment and improvement of school programs in mathematics, and (4) products that provide educational analysis and synthesis of project activities and outcomes.

What follows is a description and discussion of each of the products within each of the categories described above.

Products Defining the Parameters of the Project

1. First Coordinated Draft of the Mathematics Program Guide. Before the work of the project could progress, it was imperative that the Department of Education set guidelines for its mathematics program. It became a major responsibility of the project to produce this first draft.
2. First Revised Draft of the Mathematics Performance Expectations. The first revised draft of the mathematics performance expectations for grades three, six, eight, and twelve was developed by the project. Modified versions of these expectations now appear in the Mathematics Program Guide and in the Department's publications, Student Performance Expectations of the Foundation Program (Department of Education, August 1978).
3. Stanford Achievement Test Analysis: Mathematics Achievement in the Fourth, Sixth, Eighth, and Tenth Grades as Determined by the Stanford

Achievement Test (Lai, Scheuermann). A five-part report on the analysis of the Stanford Achievement Test 1976-77 in mathematics consisting of: (a) student performance on the achievement test, (b) computer program to provide output based on the Mathematics Program Guide, (c) computer program documentation, (d) users' guide to the computer printout based on the Mathematics Program Guide, and (e) analysis of the Stanford Achievement Test (Mathematics)--a summary. The project finalized this voluminous report.

4. Brief three-page report on the analysis of the 1977-78 Stanford Achievement Test in mathematics (Lai, May 1978). This report compared, in percentage change by grades, the performance on the mathematics portion of the 1977 Stanford Achievement Test to the performance on the 1976 test.
5. Hawaii Education Assessment Analysis, September 1977 (Lai, September 1977). The project finalized this 265-page report on the 1976 Mathematics Needs Assessment data. The report consists of an analysis of student performance in terms of "performance indicators."
6. A 22-page report on statewide deficiencies in mathematics and the prioritization of areas of concern (Whitman, 1978). This report was very basic to the project since it identified and prioritized modules needing development. Before this report could be written, each of the preceding products had to be available.

Modules and Other Materials Affecting Instruction

A total of 16 modules were piloted. The materials in some of these modules encompassed two- to five-week instructional periods whereas others covered one to two years of instruction. A total of 20 schools, 76 teachers

and 1882 students were involved. Of these 16 modules, 11 contain student and/or teacher materials developed by the project. Each of these 11 are discussed below.

7. a. All-Star Subtraction. A 40-page student booklet intended to provide lower elementary students with an intensive review of subtraction. The focus is on skill development with numerous opportunities for concentration and practice with subtraction facts.

   b. All-Star Subtraction, Teacher's Guide. A 62-page teacher's guide including lesson plans, tests and quizzes with answer sheets and keys, answer keys for the student book, and masters for subtraction star stickers and flash cards.

8. a. Number Stuff. A 44-page student booklet to provide lower elementary students with an understanding of place value.

   b. Number Stuff, Teacher's Guide. A 52-page teacher's guide including lesson plans, tests and quizzes with answer sheets and keys, answer keys for the student book, and masters for flash cards.

9. a. Learning About the Metric System in High School. A 58-page student workbook intended to acquaint high school students with the commonly-used prefixes and measurement units in the metric system through estimating and measuring activities, frame-of-reference activities, abstraction and conversion activities, and change-of-pace activities.

   b. Learning About the Metric System in High School, Teacher's Edition. A 58-page teacher's guide containing objectives for each unit of study, pre- and post-tests and quizzes, information about the metric system, a listing of materials needed including approximate costs and possible sources, and suggested teaching strategies.

10. Applying Problem Solving to Statistics and Consumer Mathematics. This 132-page teacher's manual contains a sample course in the Selected Mathematics Applications Level A courses of the Department of Education. The mathematical content in this sample Level A course includes computing with whole numbers, decimals, and fractions; expressing a percent as a ratio; estimation and rounding; collecting and classifying data; reading and interpreting charts, graphs, and tables; organizing and analyzing data by constructing graphs or tables about familiar situations.

    The manual consists of two parts. Part I describes approaches that may be used to develop a course in the Selected Mathematics Applications Level A courses and contains brief reviews of materials that are appropriate for units in statistics and consumer mathematics at this level. Part II is a sample course based on Statistics and Information Organization by Mathematics Resource Project (published by Creative Publications) and Consumer Mathematics: CM1 by Gail Spitler and Charles E. Allen (published by Rand McNally). Commentaries on various teaching strategies, supplementary worksheets, transparency masters, and quizzes and tests for this course are provided in the manual. Methods for incorporating problem-solving strategies are highlighted throughout the commentary. Where appropriate, supplementary worksheets on problem solving are included.

11. Applying Problem Solving to Statistics and the Metric System. This 99-page teacher's manual contains a sample course in the Selected Mathematics Applications Level B courses of the Department of Education. The mathematical content in this sample Level B course includes solving ratio, proportion, and percent problems; understanding and

using the relationship among common fractions, decimals, and percents; applying concepts of length, perimeter, area, and volume; changing units within the metric system; preparing and interpreting statistically-oriented graphs; collecting and organizing numerical data; and making decisions after interpreting data.

This manual consists of two parts. Part I describes approaches that may be used to develop a course in Selected Mathematics Applications Level B courses and contains brief reviews of materials that are appropriate for units in statistics and metric measurement at this level. Part II is a sample course that uses Sampling and Statistics by Johnson et al. (published by Scott, Foresman) and Learning About the Metric System in High School developed by the Curriculum Research and Development Group as student texts. The manual provides the teacher with commentaries on various teaching strategies, supplementary worksheets and transparency masters, and quizzes and tests for this course. Methods of incorporating problem-solving strategies are highlighted thoughout the commentary. When appropriate, supplementary worksheets on problem solving are included.

12. Core Algebra. This 143-page manual consists of two parts. Part I presents an analysis of some of the materials currently available that address the learner objectives listed in the Hawaii State Mathematics Program Guide of Core Algebra, a semester course for the typical high school student. Part II offers a sample course using Basic Algebra, a textbook written by Richard G. Brown, Geraldine D. Smith, and Mary P. Dolciani (published by the Houghton Mifflin Company). The sample course includes a course outline, a suggested time schedule, notes about the lessons (vocabulary lists, comments on instructional strategies, and suggested assignments) and tests and quizzes.

13. a. Measuring in Metric. A 64-page student workbook that acquaints upper elementary and junior high school students with the commonly-used prefixes and measurement units in the metric system through estimating and measuring activities, frame-of-reference activities, abstraction and conversion activities, and change-of-pace activities. The teacher can extend and adapt these activities to fit special situations that may arise in the classroom.

    b. Measuring in Metric, Teacher's Manual. A 39-page teacher's guide containing objectives for the unit of study, pre- and post-tests and quizzes, information about the metric system, a listing of materials needed including approximate costs and possible sources, and suggested teaching strategies.

14. a. Measuring in Metric (Handicapped Version). A 72-page student workbook as described above under 13.a., with adaptations for physically handicapped students.

    b. Measuring in Metric, Teacher's Manual (Handicapped Version). A 43-page teacher's guide as described above under 13.b., with suggestions for special experiences for the physically handicapped.

15. Core Geometry Manual. This 180-page manual consists of two parts. Part I of the manual contains reviews of some of the materials currently available that address the learner objectives listed in the Hawaii State Mathematics Program Guide for the Core Geometry course. Part II offers a sample course based on the Geometry worktext by Ruth E. M. Wong. The manual provides the teacher with a course outline, a suggested time schedule, commentaries on various teaching strategies, supplementary worksheets and transparency masters, and quizzes and tests for this course.

16. Selected Algebra Topics Manual. This 200-page manual consists of two parts. Part I of the manual contains reviews of some of the materials currently available that address the learner objectives listed in the Hawaii State Mathematics Program Guide for the Selected Algebra Topics course. Part II offers a sample course based on the Algebra Through Applications texts by the First-Year Algebra via Applications Project published by the National Council of Teachers of Mathematics. Part II also contains a sample course for Core Algebra based on these same texts. The manual provides the teacher with a course outline, a suggested time schedule, commentaries on various teaching strategies, supplementary worksheets and transparency masters, and quizzes and tests for this course.
17. Statistics Manual. This 158-page manual offers a one-semester sample statistics course offered in the high school mathematics program. This sample course uses Statistics and Probability in Modern Life, a textbook written by J. Newmark (published by Holt, Rinehart, and Winston). The manual includes a course outline, suggested time schedule, notes about the lessons (vocabulary, comments on instructional strategies, and suggested assignments) and tests and quizzes.

A School-Level Mathematics Assessment and Improvement Model

The project developed a model that interpreted the Foundation Program Assessment and Improvement System (FPAIS) at the school-level in the area of mathematics. It is based on the assumptions that:

1. The school-level leadership team will include the school administrator.
2. The leadership team will receive initial and follow-up inservice training in the use of the model.

3. The school is the primary unit of change.
4. The process the users go through is an agent of change.
5. The model is a continuous monitoring system.
6. The Districts and the State will set the parameters for mathematics education and provide the necessary resources to promote desired changes. Each is a secondary unit of change.

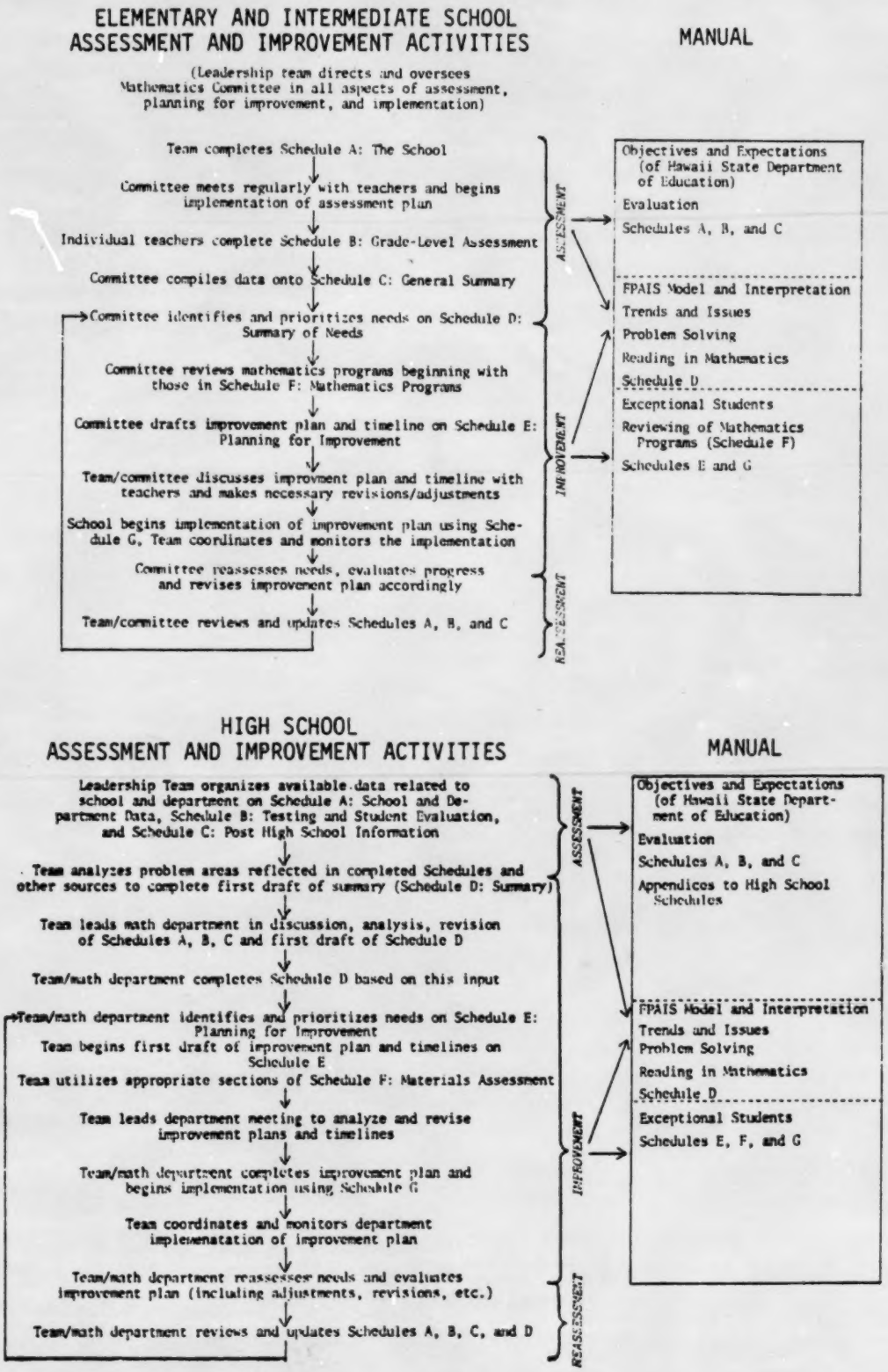
18. Mathematics: Program Assessment and Improvement Planning Manual (Whitman, 1980). (Hereinafter referred to as the "Manual") This 471-page manual contains elements of the model. In particular, it contains information on the Foundation Program Assessment and Improvement System (FPAIS), objectives and expectations for mathematics, educational trends and issues in mathematics education, evaluation, problem solving, reading mathematics, exceptional students in mathematics, and mathematics programs in higher education in Hawaii. In addition, the manual contains instruments for assisting schools in assessing and planning for improvement in school programs. The relationship of the parts of the manual and of the proposed assessment and improvement activities at the school level is shown in Figure 1.

19. Statewide Foils Analysis--Stanford Achievement Test, 1978-79 (Lai, October 1979). This 28-page document contains an analysis by grades four, six, eight, and ten of incorrect choices (foils) selected by students on the Stanford Achievement Test. Instructional implications are also given.

Educational Analysis and Synthesis

Formal evaluations of project activities were conducted including leadership training seminars, summer taining, inservice training of teachers for

Figure 1
RELATIONSHIP BETWEEN MANUAL AND ASSESSMENT AND IMPROVEMENT ACTIVITIES AT THE SCHOOL LEVEL


ELEMENTARY AND INTERMEDIATE SCHOOL ASSESSMENT AND IMPROVEMENT ACTIVITIES
MANUAL
(Leadership team directs and oversees Mathematics Committee in all aspects of assessment, planning for improvement, and implementation)
Team completes Schedule A: The School
Committee meets regularly with teachers and begins implementation of assessment plan
Individual teachers complete Schedule B: Grade-Level Assessment
Committee compiles data onto Schedule C: General Summary
Committee identifies and prioritizes needs on Schedule D: Summary of Needs
Committee reviews mathematics programs beginning with those in Schedule F: Mathematics Programs
Committee drafts improvement plan and timeline on Schedule E: Planning for Improvement
Team/committee discusses improvement plan and timeline with teachers and makes necessary revisions/adjustments
School begins implementation of improvement plan using Schedule G. Team coordinates and monitors the implementation
Committee reassesses needs, evaluates progress and revises improvement plan accordingly
Team/committee reviews and updates Schedules A, B, and C
ASSESSMENT
IMPROVEMENT
REASSESSMENT
Objectives and Expectations (of Hawaii State Department of Education)
Evaluation
Schedules A, B, and C
FPAIS Model and Interpretation
Trends and Issues
Problem Solving
Reading in Mathematics
Schedule D
Exceptional Students
Reviewing of Mathematics Programs (Schedule F)
Schedules E and G
HIGH SCHOOL ASSESSMENT AND IMPROVEMENT ACTIVITIES
MANUAL
Leadership Team organizes available data related to school and department on Schedule A: School and Department Data, Schedule B: Testing and Student Evaluation, and Schedule C: Post High School Information
Team analyzes problem areas reflected in completed Schedules and other sources to complete first draft of summary (Schedule D: Summary)
Team leads math department in discussion, analysis, revision of Schedules A, B, C and first draft of Schedule D
Team/math department completes Schedule D based on this input
Team/math department identifies and prioritizes needs on Schedule E: Planning for Improvement
Team begins first draft of improvement plan and timelines on Schedule E
Team utilizes appropriate sections of Schedule F: Materials Assessment
Team leads department meeting to analyze and revise improvement plans and timelines
Team/math department completes improvement plan and begins implementation using Schedule G
Team coordinates and monitors department implemenatation of improvement plan
Team/math department reassesses needs and evaluates improvement plan (including adjustments, revisions, etc.)
Team/math department reviews and updates Schedules A, B, C, and D
ASSESSMENT
IMPROVEMENT
REASSESSMENT
Objectives and Expectations (of Hawaii State Department of Education)
Evaluation
Schedules A, B, and C
Appendices to High School Schedules
FPAIS Model and Interpretation
Trends and Issues
Problem Solving
Reading in Mathematics
Schedule D
Exceptional Students
Schedules E, F, and G

module instruction, student attitude and achievement gains and school-level changes in leadership training schools. In addition, evaluations (of the evaluation activities) were made by the project's outside evaluator. What follows is a listing and brief discussion of each of the evaluation reports written by the project staff and of those written by the outside evaluator.

20. Evaluation of the Mathematics Modules of the Title IV Project: Improvement of School Programs in Mathematics Through a Comprehensive FPAIS Approach (Lai, July 1978). This 97-page report contains the field evaluation of four instructional units: metrics for high school, fractions, place value, and subtraction, and included are student achievements and attitudes of teachers and students.

21. Evaluation of the Title IV-C Leadership Training Workshop (Lai, 1979). This is a 37-page report on the initial leadership training workshop that lasted two weeks (four hours a day) from July 31-August 11, 1978. Information learned from this workshop provided a basis for developing the second round of leadership training.

22. Evaluation of the 1978-79 Modules and Leadership Training of the Title IV-C Mathematics Project (Lai, 1980). This 271-page report contains the field evaluations of: (1) the Curriculum Development Associates (CDA) module including the evaluation of the inservice training that the teacher participants received during the summer and throughout the year, (2) the Core Algebra module, (3) the Applications A_1 and B_1 modules, and (4) the metric modules for regular junior high school students and the metric module for physically handicapped junior high school students. In addition, this report contains evaluations of the four leadership training seminars and of site visitations.

23. Comprehensive Mathematics Project Evaluation Audit (Wilson, 1978). This is a five-page report written by an outside evaluator of all Phase I (1977-78) activities.

24. Comprehensive Mathematics Project Evaluation Audit (Draft) (Wilson, 1979). This report is written by an outside evaluator about all Phase II (1978-79) activities.

25. Comprehensive Mathematics Project Evaluation Audit (Draft) (Wilson, 1980). This is a report written by an outside evaluator of all Phase III (1979-80) activities.

26. An Assessment/Evaluation of the 1979 Summer Leadership Training Workshop (Whitman, 1979). This four-page report consists of the evaluation of each of the three three-day workshops. Information learned from these workshops provided the basis for recommending future leadership training workshops.

27. Summer 1979 Leadership Training: Summary of the Responses to the Evaluation Questionnaires (Lai, 1979). This 14-page report summarizes the written feedback obtained from each of the three three-day leadership training workshops. It presents the results first by island, and concluding with an overall summary covering all three islands.

28. Evaluation of the 1979-80 Modules and School-Level Assessment and Improvement Activities of the Title IV-C Mathematics Project (Lai, 1980). This 180-page report contains the field evaluations of: (1) the CDA module, (2) Iowa Problem Solving Project module, (3) Selected Algebra Topics module, (4) Core Geometry module, (5) Statistics module, and (6) Intermediate School Mathematics Program module. In addition, this report contains evaluations of the leadership training.

29. Final Report of the Improvement of School Programs in Mathematics

Through a Comprehensive Foundation Program Assessment and Improvement System (FPAIS) Approach Project (1977-80) (Whitman, 1980). This is the project's 57-page final report. It includes a description and discussion of project objectives, methodology, products, results, and recommendations.

IV. Project Results and Discussion

The major objective of this project has been the reduction of mathematics program deficiencies as identified through state-level assessments and the consequent improvement of school mathematics programs. The extent to which this three-year project has been effective in reducing these deficiencies and attaining its major objective will be discussed by considering each of these deficiencies in turn. In conjunction with this discussion, the following concerns will also be addressed:

1. The viability of the FPAIS in improving school programs in mathematics.
2. The effectiveness of the leadership training program in improving school programs in mathematics.
3. The effectiveness of the module concept in improving school programs in mathematics.
4. The utility of the Stanford Achievement Test results in improving school programs in mathematics.

Mathematics Curriculum Documents

A major result of the project was the production of a coordinated draft of the state's newly-adopted Mathematics Program Guide. In addition, the project through its numerous activities has assisted the Department in the guide's implementation and interpretation. The School-Level Assessment and Improvement Model, developed by the project, incorporates the broad mathematics goals and particular learner objectives found in the Mathematics Program Guide. As school personnel conducted their assessment and improvement activities, they simultaneously became better versed

in the goals and objectives of the guide. In fact, one educational specialist pointed out that a strength of the assessment and improvement model is its incorporation of the goals and objectives of the guide. Principals have noted that teachers now see the guide, rather than the adopted text, as the basis for their mathematics program.

By correlating the test results of the Stanford Achievement Test to the goals and objectives of the guide in the Department's computer printout, the project further assisted school personnel in seeing the guide as the basis for their mathematics curriculum and as the basis for analyzing student achievement. Hence, at the school level, the guide has provided the needed framework for program assessing, planning, and desired changes.

Another means by which the project assisted in the implementation and interpretation of the guide has been the incorporation of the goals and objectives of the Department's mathematics program into the modules developed. For example, in all of the manuals developed for sample courses emphasis has been on communication and verbal interaction in the classroom, the development of problem-solving behavior by students, and the modeling of such behavior by the teachers.

The project, through its leadership training activities, implemented the objectives and goals of the guide by emphasizing communication and problem-solving activities needed for program improvement. Also, the Manual, which the project developed as part of the school-level assessment and improvement model, incorporates major mathematics goal areas for study and reference. In particular, these include the areas of reading and problem solving. An analysis of major K-8 alternative mathematics programs is also provided in the Manual. This analysis is based on the

major goals and objectives of the guide. The project, by recommending to the Department those modules for piloting that emphasize the goals and areas of emphasis of the guide, has assisted the Department in its implementation of the guide. For example, modules using materials such as Curriculum Development Associates Mathematics, Intermediate School Mathematics Program, and Geometry by Ruth E. M. Wong were recommended to the Department for piloting because each emphasized problem solving and communication skills development.

In summary, the project has assisted the Department in eliminating a major mathematics program deficiency by providing the Department with its first working draft of the Mathematics Program Guide. Furthermore, the project has assisted the Department in its implementation and interpretation of the guide.

Curriculum Guides and Examples of Courses

A second major deficiency in the state's mathematics program was the lack of curriculum guides for the newly-designed secondary mathematics program. The newly-created courses, Selected Mathematics Applications (Level A and Level B), Core Algebra, Core Geometry, Selected Algebra Topics, and Statistics, lacked curriculum guidelines and sample courses of study with suggested teaching strategies. Courses already in existence, such as Probability and Logic, also lacked curriculum guidelines or sample courses of study. The project has assisted in reducing this deficiency by developing curriculum guidelines and sample courses of study for all the abovenamed newly-designed courses, with the exception of Statistics. For Statistics, only a sample course was developed. Further, the courses of study

were pilot tested in the schools.

Since the Mathematics Program Guide emphasizes communication and problem solving in the classroom, the sample courses of study that were developed emphasized communication and problem-solving skills. Teachers were expected to model and use appropriate strategies to teach these skills to their students. A finding in the piloting of courses of study has been the lack of confidence on the part of some teachers that students could learn such skills; some teachers even questioned the need for the students to do so. For those teachers who did try to teach such skills it became apparent that the inservice training provided by the project did not sufficiently teach teachers how to model and use instructional strategies to teach communication and problem solving in the classroom. The fact that some teachers do not believe students can or should learn communication and problem-solving skills in the mathematics classroom, that some lack the needed instructional strategies needed to teach these skills, and that some do not model such skills themselves, may to an extent account for the low test performance on mathematical applications by Hawaii's students. Hence, a much greater effort must be made by the Department than could be made by the project to improve teachers' attitudes and skills in developing communication and problem-solving skills in the classroom.

In summary, the project did assist the state in reducing a major deficiency in the mathematics program by developing curriculum guidelines and courses of study and by piloting the courses of study. While not all courses of study were successfully piloted, the field evaluations show that in some cases the intended pilots were not fully implemented. Various reasons accounted for this lack. One of these, however, was an

inadequate inservice component. In retrospect, it is apparent that the teachers needed much more inservice training in understanding and helping their students develop process skills than anticipated.

School-Level Curriculum Management System

A third major deficiency in the state's mathematics program was the lack of a working model of a curriculum management system based on FPAIS. The project has developed and piloted such a model. Indications are that the model is sound and workable. The field evaluations indicate that such a system can and does lead to the improvement in school programs in mathematics. Changes that have occurred in some schools that piloted the model include:

1. Development of long-range plans based on school-wide assessments.
2. Implementation of plans based on school-wide assessment and planning.
3. Teachers' awareness of the school's total mathematics program, in addition to that portion for which they were directly responsible.
4. Increased communication among teachers and between teachers and administration.
5. Increased knowledge about mathematics programs and resources and the means by which assistance may be obtained.
6. Awareness that schools have become more program-oriented (Mathematics Program Guide) and less textbook-oriented.
7. Ability to pinpoint certain content and process deficiencies in their students.

8. Ability to elicit and obtain help for their identified school deficiencies.
9. Increased knowledge about the Mathematics Program Guide and ability to relate their mathematics program to that of the state's.
10. Institution of plans to evaluate their curriculum changes.

The elements of the model are contained in the leadership manual that the project developed. Schools should be able to use the manual with inservice training. The project has provided inservice to leadership teams in the use of the model and the elements of the Manual. Based on field evaluations of summer workshops, seminars, and site visits, the inservice has been effective in general. Has this training of leadership teams been effective in improving school programs in mathematics? In reviewing the "plans for improvement" developed by schools the identification of procedural goals such as "need to attend to problem solving," "need to provide provisions for independent investigations by students," "need to incorporate manipulatives in instruction," and "need to relate mathematics to the students' environment" as well as content goals indicate that most schools recognize the need to improve their school programs by attending to the mathematics experiences as well as the content that students are provided in the classroom. In a number of the schools' plans, the need for teacher inservice in teaching process skills such as problem solving was identified and given high priority for mathematics program improvement activities. In some schools, team members have attended inservice sessions on problem solving while others are planning to attend such sessions.

At the secondary level, schools have started to plan programs for students who have generally been "passed on" or "dumped" into a general mathematics course. They have also started to consider alternative programs for students needing a less rigorous course for college preparation. Leadership training has assisted the schools in their planning by helping them use test and non-test data in identifying program deficiencies. Available resources for the schools to consider have also been identified. Leadership training, too, has provided schools with an understanding of a school-wide mathematics program. Such an understanding is necessary for planning for improvement in school programs in mathematics.

Insofar as the model developed by the project is based on FPAIS, there is no doubt that FPAIS is viable in improving school programs in mathematics. It has acted as a strong catalyst for change when interpreted for the respective school level, as the project has. It is worth noting that most participants in the pilot of the assessment/improvement model feel that such a model may be utilized by other subject areas.

The assessment and improvement model has been effective in flagging out areas of mathematics education that schools need to attend to. In some cases, large areas of study and large student populations have been identified for further attention. In the secondary schools, areas that were identified were those pertaining to the applications of basic mathematics for a sizable percentage of the student population. In these situations, the availability of modules developed by the project proved to be of value since schools asked for examples of what they might do to improve programs once they identified and accepted the responsibility for reducing the mathematics deficiencies.

The module concept, as described on page 6, provides not only for

sample units or courses of study but also identifies alternative materials and instructional strategies that schools may utilize in developing their own course of study should the sample course be inappropriate for their situation. Modules have fulfilled a need that teachers and administrators have for sample units or courses, along with instructional suggestions and alternative materials. While the modules fulfill a school need, they also function as catalysts for school change by indicating how and what might be done in the classroom. They also communicate, via the materials used, the goals and objectives of the state's mathematics program in specific content area(s).

The course materials selected for module development and piloting were chosen to reduce or eliminate deficiencies in the state's mathematics program relative to content and process needs. By "process needs" is meant the need to emphasize and develop communication and problem-solving skills in the classroom. Since process skills cannot be taught over a short period of time but must be incorporated into a course of study, semester and one- to two-year modules were chosen for piloting whenever possible. Even here, the effect of the emphasis on communication and problem solving on student attitude and achievement cannot be fully tested. However, the effect of such teaching on teachers' perception of student ability and on mathematics does begin to surface. In studying the teachers' logs and evaluations, attitude changes on the teachers' part become evident. Such changes are a key to the improvement of school programs in mathematics.

Some modules were identified to handle particular content needs. These included the metric, place value, and fraction modules. All of these modules resulted in educationally significant student gains (Lai,

1978). If schools identify student deficiencies in metrics, place value, or fractions after a school-wide assessment, they must prioritize these deficiencies relative to other identified school needs. They must view these deficiencies and what they plan to do about them within the context of their total mathematics program. It is within the context of this type of program-wide school-level assessing and planning that the modules will be most effective in improving school programs.

The introduction of modules can lead to positive changes on the part of students and teachers. However, one must be certain that the teachers are prepared (inservice and materials support) to fully implement the module. Without a commitment by the teachers and administration to fully implement a module, one cannot say much about the effects of the module.

In summary, modules fulfill school-level needs for sample materials and instructional strategies, they function as a catalyst for school program changes, they incorporate state mathematics program goals and objectives in specific content areas, they can change a teacher's instructional style, and they can reduce student mathematics achievement deficiencies. However, a less than effective mathematics program may ensue if schools and teachers incorporate modules without consideration of the total mathematics program. Hence, it is inferred that the module concept would be more effective in improving programs in school mathematics when used in conjunction with a school-level assessment and improvement model.

Student Achievement

A fourth major deficiency in the state's mathematics program is the lack of student achievement in certain skills, concepts, and applica-

tions of mathematics. Some of these have been identified by a statewide analysis of the Stanford Achievement Test results for grades four, six, eight, and ten and of the 1976 Mathematics Needs Assessment data for grades four and eight. Others were identified as deficiencies based on an analysis of the Mathematics Program Guide, Department of Education performance expectations and essential competencies for high school graduation, professional experience and judgment, teacher comments, and nationwide studies such as that of the National Advisory Committee on Mathematical Education (NACOME). Because of the changing mathematical needs of society and the lag of mathematics program changes in the schools, school programs have not offered certain basic areas of study in mathematics and the result has been that standardized tests such as the Stanford Achievement Test do not measure these basic areas. Also, since the Stanford Achievement Test is based on the curriculum of the 1960's, it cannot be expected to reflect the curriculum of the Seventies nor of the Eighties. In actuality, a study of the Mathematics Program Guide (1978) and the Stanford Achievement Test reveals that the Stanford Achievement Test is weak in terms of coverage of the Mathematics Program Guide categories: 29 percent at grade four; 50 percent at grade six; 48 percent at grade eight; and 29 percent at grade ten.

Although the Stanford Achievement Test is weak in terms of program coverage, an analysis of student performance based on it should provide a substantial amount of useful information to educational specialists at the state and district levels. These specialists are generally concerned with aggregate responses relative to national norms and performance expectations, gains made between grade levels, and relative performance of

districts and schools. In the piloting of the school-level assessment and improvement model, school-level leadership teams were instructed in the use and analysis of their school's Stanford Achievement Test test results. These results provided the schools with assessment data which they utilized along with other data (test and non-test) in studying the schools' mathematics program. Used in this fashion, the Stanford Achievement Test test data at the school level have value.

In summary, statewide deficiencies in student achievement in mathematics were identified by analyzing test and non-test data. A major deficiency area identified was problem solving, including the application of mathematical skills and concepts and the solution of verbal problems. Other areas identified were measurement, geometry, statistics, and algebra. Particular concepts identified were: fractions, metric units, and place value. Skill with the subtraction algorithm was also identified. For some of the identified areas, deficiencies were in the programs offered rather than student performance. For these areas, knowledge of whether student gains are possible once instruction is provided is paramount to program planning and improvement.

The project developed modules to reduce student deficiencies in identified topics, concepts, and skills.* The assumption was made that when schools identified the same deficiencies they would use these modules and the materials identified in them in an attempt to reduce the deficiencies. Although the modules were tested with limited groups of students, the intent of the pilot was to indicate to teachers and administrators the promise such modules held in reducing deficiencies.

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*See listing "Project Teacher/Student Materials" in the bibliography.

A first step in reducing identified student and program deficiencies in mathematics is to have teachers and administrators aware of such deficiencies. The project was able to bring about this awareness in the schools that piloted the assessment and improvement model. This is evidenced by the number of schools that identified problem solving as an area of need and have begun inservice in this area (Lai, 1980). A second step in reducing deficiencies is to provide or identify instructional materials that address such deficiencies. The project was able to do this by its development of modules in which a listing of resource materials and sample units of courses are provided. It also assisted the Department in updating its Approved Instructional Materials list to conform to the Mathematics Program Guide. A third step is to provide for the inservice training of teachers and administrators so that the identified materials may be appropriately implemented. The extent to which the project was able to do this is reflected in Table 1, in which the degree of implementation of pilot materials is indicated. In some cases the less-than-desirable implementation was due to circumstances beyond the schools' and project's control, such as the United Public Workers' strike and storms. In other cases, the student population that piloted the materials was inappropriate. This was true in the case of the Core Algebra and Statistics modules. A plus (+) indicates good implementation, a check (✓) indicates fair implementation, and a minus (-) indicates poor implementation. Generally, "good" implementation indicates (1) appropriate students, (2) appropriate instructional time spent on the materials, and (3) appropriate instructional strategies employed by the teachers. "Fair" implementation indicates a major

Table 1
DEFICIENCY AREAS ADDRESSED, EXTENT OF IMPLEMENTATION, AND STUDENT GAINS ON PROJECT MODULES

MODULE *	DEFICIENCY AREA BEING ADDRESSED	EXTENT OF IMPLEMENTATION**	STUDENT GAINS***
a. *Learning About the Metric System in High School*	Knowledge and use of metric units	+	+
b. *Measuring in Metric*	Knowledge and use of metric units	+	+
c. *Measuring in Metric* (handicapped)	Knowledge and use of metric units	✓	+
d. Fractions I	Concept of a fraction Simple skills with fractions	+	+ +
e. Number Stuff	Concept of place value	+	+
f. All Star Subtraction	Whole numbers--subtraction algorithm	+	+
g. *Core Algebra*	Learner objectives for a core algebra course	✓	+
h. Problem Solving for Teachers	Problem solving and communication	-	o
i. *Core Geometry*	Learner objectives for a core geometry course	+	+
j. *Statistics*	Learner objectives for a statistics course	-	+
k. *Iowa Problem Solving Project*			
1) *Intermediate School Level*	1) Problem solving and communication in mathematics	+	+
2) *Elementary School Level*	2) Problem solving and communication in mathematics	+	+
l. *Selected Algebra Topics*	Learner objectives for a selected algebra topics course	✓	+
m. *Intermediate School Mathematics Program*	Problem solving and communication in mathematics	✓	+
n. *Applying Problem Solving to Statistics and Consumer Mathematics*	Selected learner objectives for a Level A applications course Problem solving and communication in mathematics	-	o o
o. *Applying Problem Solving to Statistics and the Metric System*	Selected learner objectives for a Level B applications course Problem solving and communication in mathematics	-	+ o
p. *CDA Mathematics*	Problem solving and communication skills	✓	+

* Italicized modules reflect program areas not being offered in the schools.
** +: good implementation
✓: fair implementation
-: poor implementation
*** Student gains refer to pre-post class achievement relative to the deficiency area being addressed by the module as measured by test, project module coordinators, and teacher assessments.
+ indicates positive achievement.
o indicates no achievement.

weakness in one of these. "Poor" implementation indicates two or more major weaknesses. For some of the modules, in particular, Applying Problem Solving to Statistics and Consumer Mathematics and Applying Problem Solving to Statistics and the Metric System, implementation of the materials could have been better with an improved inservice component.

The development of modules along with the piloting of materials were chosen to address certain known student deficiencies in areas of mathematics or assumed student deficiencies because no instructional program was offered in these areas. These are identified in Table 1. The italicized modules were developed and materials piloted primarily because those program areas were not being offered in the schools' programs.

Student gains relative to the deficiency areas the module addresses are given in Table 1. A plus (+) indicates a positive gain and a zero (o) indicates no gain. Gains are pre-post gains as measured by tests, teachers, and project module coordinator. Of the 16 module materials piloted, 13 showed positive student gains. For the three that showed no gains, implementation was judged to be poor. Hence judgment regarding the materials of these modules in addressing the deficiencies is difficult to make.

RESULTS AND THE MATHEMATICS PROGRAM GUIDE

Both the curriculum modules and management system developed by the project have addressed the emphases of the guide. A discussion relating the curriculum modules, curriculum management system, and the emphases of the guide follows with the foci being the specific areas of emphases of the guide:

1. Communication. Language development and communication skills were stressed in the following modules: Curriculum Development Associates mathematics, Intermediate School Mathematics Program mathematics, Applying Problem Solving to Statistics and Consumer Mathematics, Applying Problem Solving to Statistics and the Metric System, Core Geometry, Selected Algebra Topics, and Statistics. Communication and reading were major categories for assessment and improvement in the curriculum management system. Communication among teachers, administrators, and district personnel was enhanced through project activities.
2. Delay of certain symbolism, technical language, topics. The rationale for this emphasis is discussed in the Manual developed by the project. The implementation of this emphasis is reflected in the Intermediate School Mathematics Program, Core Algebra, Core Geometry, and Selected Algebra Topics modules.
3. Metric/decimal systems. A discussion of this emphasis is found in the Manual. In addition, three metric modules were developed.
4. Wider educational opportunity. The newly-designed Mathematics Program Guide provides for wider educational opportunity for all students. However, several of the courses reflected in the secondary mathematics program needed to be developed and piloted. The project assisted in this effort. In particular, it developed modules (sample courses and/or course guides) and piloted sample course materials for the following courses: Statistics, Core Geometry, Core Algebra, Selected Algebra Topics, Selected Mathematics Applications (Level A and Level B). The results

cognitive and others) support the viewpoint that more students can study more mathematics if the curriculum is a flexible one that provides for a greater range of options to accommodate the diverse needs of the student population.

5. Reasoning processes. Essentially the emphasis is on problem solving. Problem solving is stressed in the Manual and was stressed in the leadership training conducted by the project. Certain materials were identified and developed for piloting because of their emphasis on problem solving. Also a module stressing the inservice training of teachers on problem solving was piloted.

6. Basic skills. The Mathematics Program Guide's description of basic skills includes more than computational skills. It includes problem solving, applying mathematics in everyday situations, alertness to the reasonableness of results, estimation and approximation, appropriate computational skills, geometry, measurement, reading, interpreting and constructing tables, charts, and graphs, using mathematics to predict, and computer literacy. With the exception of computer literacy, the project identified materials for the modules and for piloting that addressed the basic skills listed. For example, the Fractions I and Applying Problem Solving to Statistics and Consumer Mathematics materials addressed the skill of applying mathematics in everyday life, the Subtraction and Fractions I materials addressed computational skills, and the Statistics and Applying Problem Solving to Statistics and the Metric System materials ad-

dressed reading, interpreting, and constructing tables and graphs and using mathematics to predict. Computer literacy was not addressed by the project because there exists a statewide freeze on the purchase of computer equipment.

All of the basic skill areas are incorporated into the assessment instruments of the assessment and improvement model developed by the project. Furthermore, they are discussed in the Manual and were discussed during the leadership training conducted by the project. Schools that piloted the assessment and improvement model and teachers who piloted module materials are becoming more aware of the broader definition of basic skills as described in the guide.

7. Use of physical models and pictures. This is emphasized in the assessment instruments of the assessment and improvement model. They are also emphasized in materials for the following modules: Learning About the Metric System in High School, Measuring in Metric, Measuring in Metric (for the handicapped), Fractions I, Number Stuff (place value), All Star Subtraction, Intermediate School Mathematics Program, Applying Problem Solving to Statistics and Consumer Mathematics, Applying Problem Solving to Statistics and the Metric System, and Curriculum Development Associates mathematics.

In conclusion, the project has addressed the emphases of the Mathematics Program Guide through the development and piloting of curriculum modules and a curriculum management system. These efforts by the project have resulted in improved school mathematics programs and can continue to assist schools in improving their mathematics programs especially when the recommendations in the next section are implemented by the Department of Education.

V. Recommendations

Based on all aspects of the project, the following recommendations for mathematics program improvement at the state, district, and school levels, are suggested. The first set of recommendations pertain primarily to the assessment and improvement model developed by the project. The second set of recommendations deal primarily with the utilization of course and other classroom support materials developed by the project. The third set discusses the reports of the project.

The School-Level Assessment and Improvement Model

1. The school-level assessment and improvement model should be implemented by the Department of Education as an effective change agent for the improvement of school mathematics programs.

Implementation of the Model

2. The administrators and staff of the Office of Instructional Services and the district education specialists should receive inservice training in the use of the model from the project staff.
3. The schools should have the major responsibility for implementing the models.
   a. Process and outcomes are both important facets of the model. Hence, individuals outside of the schools should not "do the assessment for the schools."
4. Each district should decide on the best way to implement the model.
   a. Before schools are encouraged to implement the model, the district must be committed to the model and give high priority to its implementation.
   b. The distict should elicit the technical assistance of mathematics educators to implement the model if district mathematics personnel are

not available.

Technical assistance in mathematics education may be obtained from (a) school personnel, (b) state personnel, (c) college and university personnel, and (d) the Hawaii Council of Teachers of Mathematics.

5. The district should be ready to answer questions schools may have regarding the model's use.
6. The district should provide or communicate to schools available personnel, curriculum, and instructional resources.
   a. The district should have an updated directory of personnel resources.
   b. The district should have an updated listing of district mathematics resources.
7. Each district should provide district-wide directions in mathematics education that are further delineations of general district goals and the state mathematics program goals.
   a. A three-to-five year plan for the assessment and improvement of mathematics education at the district level should be developed by each district.
   b. The district should involve and communicate to the schools (teachers and administrators) district-wide directions in mathematics education.
8. The state should be responsible for keeping the Manual updated.
9. The state should continue to support the development of personnel and materials resources at the district levels.
   a. The state should conduct workshops to assist district personnel in developing long-range assessment and improvement plans in mathematics education for their districts.
10. The state should develop a six-year statewide assessment and improvement plan for mathematics education.

Leadership Training

11. The leadership training needed to implement the model should be conducted in the four stages developed by the project: orientation, workshop, site visits, and follow-up. (See Appendix for details of these stages.)
12. The district should provide "awards" to leadership training participants. University of Hawaii course credits, Department of Education "B" credits, or a certificate of accomplishments from the state or district are examples.
13. The leadership training should be conducted by persons who are knowledgeable about the programs and policies of the Department of Education, knowledgeable about mathematics education, and relate positively to school personnel.
14. Districts that lack appropriate and/or sufficient personnel to conduct the leadership training should utilize the following options:
    a. Request assistance from the State Department of Education.
    b. Contract the University of Hawaii to provide such services.
       This amounts to the districts providing the tuition expenses of the participants and the travel expenses of the trainer of the leadership teams. This amounts to a cost of approximately sixty dollars (for two credits per participant).
    c. Contract other institutions of higher learning.
    d. Utilize the inservice arrangement the Department has with the College of Education, University of Hawaii.
       Under this arrangement the University provides a service to the Department in which the University has related research and development interest. Participants may receive credit provided they pay the necessary registration fees and tuition. The cost to the district

is that of the participants' materials and travel of university personnel.

15. Contract qualified individuals. (With this arrangement the granting of University of Hawaii credits cannot be assumed as an option.)

Other

16. The Department should develop similar school-level assessment and improvement models for other subject areas.

Modules, Classroom Materials, and Instruction

1. The Department should continue to implement the Mathematics Program Guide.

Curriculum

2. The Department should set statewide deadlines for implementing the newly-restructured mathematics program.
3. The Department should implement the following modules developed by the project:
   - Selected Algebra Topics and Core Algebra
   - Core Algebra
   - Core Geometry
   - Selected Applications B_1: Applying Problem Solving to Statistics and the Metric System
   - Intermediate School Mathematics Program
   - CDA Mathematics (1-6)
   - Learning About the Metric System in High School
   - Measuring in Metric
   - Measuring in Metric (handicapped)
   - Fractions I
   - Number Stuff (place value)
   - All Star Subtraction

Each of these modules addresses needs in the guide.

4. The Department should implement the Iowa problem solving materials as supplemental materials to be incorporated into the regular curriculum on a schedule spread throughout the year.
   a. Implementation should not take the form of intensive short-term instruction.
5. Schools should implement semester and year-long modules only after systematically assuming and planning for school-wide mathematics program improvement.

Inservice

6. The Department should provide further inservice on the Mathematics Program Guide.
   a. Module materials developed by the project and curriculum guides developed by the Department should be used during the inservice to clarify the guide's intent.
7. The Department should provide inservice to help teachers expand their concept of basic skills goals of mathematics instruction to include process as well as content objectives for all students, and their instructional repertoire to include techniques for teaching reading of mathematical content, for promoting problem-solving behavior, for promoting verbal communication in the classroom, for handling multiple groupings in the classroom, and for leading classroom discussions.
8. The Department should establish demonstration sites to model the teaching of processes and content.
   a. These sites should be used to provide on-the-job training for teachers.
9. The Department should provide indepth inservice training in the use of the newly-developed course guides and modules developed by the Department and the project.

10. The Department should establish a cadre of elementary and secondary mathematics resource teachers at the district level.
    a. Resource teachers should provide inservice training and consultative services to the schools.
11. The Department should develop an inservice program plan, including courses, in conjunction with institutions of higher learning.

Resource Materials

12. The state, district educational specialists, and classroom teachers should develop resource centers at the district and/or school level.
    a. The resource centers should include professional libraries of instructional materials, descriptions of successful techniques and activities, and self-automated teacher training materials.
    b. Materials developed by the project should be housed at the resource centers.
    c. Workshops on the use of project materials should be held in or close to these resource centers.
    d. The resource center should contain a sample copy of all mathematics materials listed in the Authorized Instructional Materials.

Development of Support Materials and Activities

13. The Mathematics Educational Specialist should regularly update the resource sections of the modules.
14. The Department should give priority to the development of additional sample courses for Core Algebra and Selected Algebra Topics.
15. The Department should try out the revised Selected Applications A_1: Applying Problem Solving to Statistics and Consumer Mathematics module before recommending it to schools.
16. The Department should try out the Statistics module developed by the project before recommending it to schools.

17. The Department should solicit the assistance of classroom teachers, the Hawaii Council of Teachers of Mathematics, and mathematics educators at the University of Hawaii to develop modules for the newly-designed courses of the restructured high school mathematics program.
18. The Department should include in its Authorized Instructional Materials (AIM) list the mathematics programs discussed in Schedule F of the Elementary and Intermediate School Schedule in the Manual.
19. The Department should include in its AIM list all module materials recommended for implementation.

Evaluation of Modules

20. The Department should continue to evaluate newly-designed modules before implementing them.
    a. The evaluation of modules should be based on the modules objectives, using evaluation strategies consistent with these objectives.
    b. Longitudinal evaluation of individual problem-solving ability should be developed. The acquisition of problem-solving skills is a long-term process and should not be evaluated solely with short-term measures.
    c. Test scores should not be used as the sole index of success in newly-designed modules.

Dissemination

21. The Department should develop a dissemination plan to inform the public of its improvement efforts and to insure that staff and teachers at all levels are aware of improvement efforts.
22. A mathematics newsletter should be developed by the Mathematics Education Specialist to inform teachers of newly-developed curriculum guides and modules. The newsletter should also be used as a forum for the exchange and sharing of ideas and information.

Reports

1. a. The Department should make the Stanford Achievement Test (Mathematics) results available to schools on a computer printout based on the Mathematics Program Guide.

   b. The Department should make available to schools a user's guide as found in the Stanford Achievement Test Analysis: Mathematics Achievement in the Fourth, Sixth, Eighth, and Tenth Grades as Determined by the Stanford Acheivement Test.

   c. The Department should conduct inservice on how to analyze and use the Stanford Achievement Test (Mathematics) results.

2. a. The Department should disseminate the Statewide Foils Analysis--Stanford Achievement Test, 1978-79 report to the district educational specialists and mathematics resource teachers.

   b. The State or District should sponsor inservice activities wherein the report is disseminated to mathematics teachers.

3. a. The project administrator should present the results and recommendations of project activities to state and district personnel.

   b. The district educational specialist should communicate the field evaluations and final report to the schools.

   c. The state should release portions of or the entire field evaluations (Years 1, 2, and 3) and the final report to the schools.

APPENDIX

Leadership Training Stages

Stage One: Orientation. This stage is to orient school principals to the total model. The nature of their commitment and that of their schools is to be made clear. This orientation is to be sponsored by each district. Each district decides when and how the orientation takes place. Possible alternatives include: (a) district personnel conduct the orientation, (b) district and consultative help from the developers of the model be utilized, and (c) district utilizes consultative help from the developers of the model to conduct the orientation.

Stage Two: Workshop. This stage is to train the team in the nature of and in the use of the model. It is at this stage that the districts will find the assistance of a mathematics educator of great value. That person would be able to discuss the trends and issues of mathematics education, evaluation of mathematics achievement, and the procedures and content of mathematics in the schools.

This stage of the model's implementation should take approximately one day. A possible outline for the day's content follows:

8:30 - 9:00	general orientation
9:00 - 10:00	orientation to mathematics education: trends and issues; areas of concern and need for improvement at the district, state, and national level
10:00 - 12:00	evaluation in mathematics education: test and non-test data; using and interpreting test results: Stanford Achievement Test, Competency-Based Measures, Hawaii State Test of Essential Competencies

1:00 - 3:30 orientation to the Assessment/Improvement model: relationship to FPAIS, Mathematics Program Guide, Department of Education administered tests; the Manual; guidelines for assessing, planning for improvement, and implementing plans

Stage Three: Site Visits. The purpose of the site visits is to motivate and enhance the implementation of assessment and improvement activities at the school level. A total of two to three site visits should be held. Where appropriate and feasible the site visits should include seminar-like activities. For example, further discussions on problem solving, reading, alternative materials, and so on.

Site visits should be planned for at least an hour's duration. Schools should be informed of this need and a visitation plan should be worked out between schools and coordinator during stage two activities.

A major goal of the site visits is to have schools develop and begin to implement their plans.

Stage Four: Follow-up Site Visits. At least two follow-up visits should be held. Where feasible these should be held during the first and fourth quarter. The purpose of the first visit is to insure that schools are in fact "on their way" in implementing improvement activities. Also, consultative assistance with respect to mathematics education may be provided as needed. The second visit is to insure that improvement activities will continue the following and subsequent years. Also, consultative help with respect to mathematics education may need to be provided.

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